Idaho State Department of Agriculture
Division of Agricultural Resources

Seven-Year Water Quality Monitoring Results for Twin Falls County 1998-2004

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Introduction

The Idaho State Department of Agriculture (ISDA) developed the Regional Agricultural Ground Water Quality Monitoring Program to characterize degradation of ground water quality from contaminants leaching from agricultural sources. The ISDA currently is conducting monitoring in twelve separate geographic regions in Idaho (Figure 1). The objectives of the program are to characterize ground water quality related to primarily nitrate and pesticides, determine if pesticide use contributes to aquifer degradation, relate data to agricultural land use practices, and provide data to support Best Management Practices (BMP) and/or regulatory decision making and evaluation processes.

The Twin Falls County regional monitoring project began in 1998 as a result of previous monitoring by the Idaho Department of Water Resources (IDWR) Statewide Ambient Ground Water Quality Monitoring Program. IDWR identified five domestic wells in Twin Falls County exceeding the Environmental Protection Agency Maximum Contaminant Level (MCL)[1] of 10 milligrams per liter (mg/L) for nitrate (Neely and Crockett, 1999). To establish this regional monitoring project, the ISDA randomly selected 75 domestic wells in the northern Twin Falls County area and coordinated with homeowners to conduct ground water sampling.

Nutrients, common ions, and pesticides were evaluated for seven years (1998-2004). Laboratory results indicated that numerous domestic wells in the area had nitrate concentrations just below 10 mg/L during the seven-year period. Three wells tested had nitrate concentrations exceeding the EPA health standard. In addition, low level detections of various pesticides were found in several sampled wells during the 1998, 1999, 2000, and 2002 testing periods.

[1] MCLs represent the EPA health standard for drinking water.

The ISDA is currently working to advise residents and officials of the area to reduce further ground water contamination and possible health risks. Ground water monitoring will continue through the year 2004 to assist with these efforts.

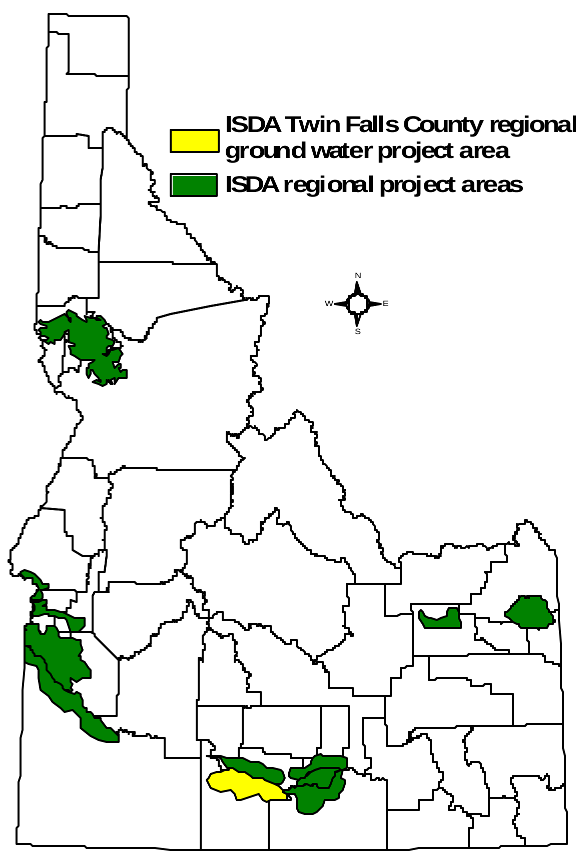


Figure 1. Location of Twin Falls County regional monitoring project and other regional project areas.

Methods

To establish this project, ISDA assessed IDWR Statewide Program nitrate, chloride, and atrazine monitoring data. ISDA statistically determined that sampling 75 randomly selected domestic wells would provide adequate data to evaluate overall ground water quality underlying the area. All sampling was conducted after a quality assurance project plan (QAPP) was established. Permission was gained from the land owners prior to sampling.

Nutrients and other common ions were evaluated every year since 1998. All sample collections followed established ISDA protocols (on file at ISDA main office) for handling, storage, and shipping. Samples were sent to the University of Idaho Analytical Sciences Laboratory (UIASL) in Moscow, Idaho in 1998, 2002, 2003, and 2004. From 1999 to 2001 samples were sent to the Magic Valley lab in Twin Falls. Both labs conducted tests for nitrate, nitrite, ammonia, orthophosphorus, chloride, sulfate, bromide, and fluoride. UIASL used EPA Methods 300.0 and 350.1 and Magic Valley used Standard Methods. Duplicates, blanks, and matrix spikes/matrix spike duplicates were collected and submitted as a part of the QAPP.

Pesticide samples were collected in 1998, 1999, 2000, and 2002 were sent to the UIASL. UIASL used gas chromatography scans for pesticides utilizing EPA Methods 507, 508, and 515.1. Duplicates, blanks, and matrix spikes/matrix spike duplicates were collected and submitted as a part of the QAPP.

Description of Project Area

The Twin Falls County regional project encompasses an approximately 25 mile wide and 40 mile long area of northern Twin Falls County south of the Snake River (Figures 3). Irrigated crop land and dairy cattle operations are the two primary agricultural activities in the area.

Land Use

Potential sources for nitrate leaching to ground water in the area include applied nitrogen-based fertilizers, septic systems, cattle manure, legume crops, and wastewater lagoons. Based on IDWR land use data, over 90% of agricultural lands within the project area are irrigated by gravity flow. On average, 242,600 acres of the following crops are grown in Twin Falls County: alfalfa, barley, oats, wheat, beans, potatoes, sugar beets, and corn (Idaho Agricultural Statistics Service, 2004). In addition there are approximately 70 dairies milking 48,751 cows within Twin Falls County (Benavides, 2004).

Geology

Surface or near surface basalt flows which offer potential paths for leaching of contaminants via fractures underlie much of northern Twin Falls County. Based on well logs from domestic wells sampled as part of the project, depth to first ground water is variable ranging from about 10 feet to 300 feet below land surface. Well logs indicate that the ground water aquifer is situated in fractured basaltic rocks with intercalated sands and gravels.

Precipitation

During the years of 1998-1999 precipitation was higher than normal in Twin Falls County, but since 2000 it has been below normal (10.66 inches) five out of the last seven years of the ISDA water quality monitoring project.

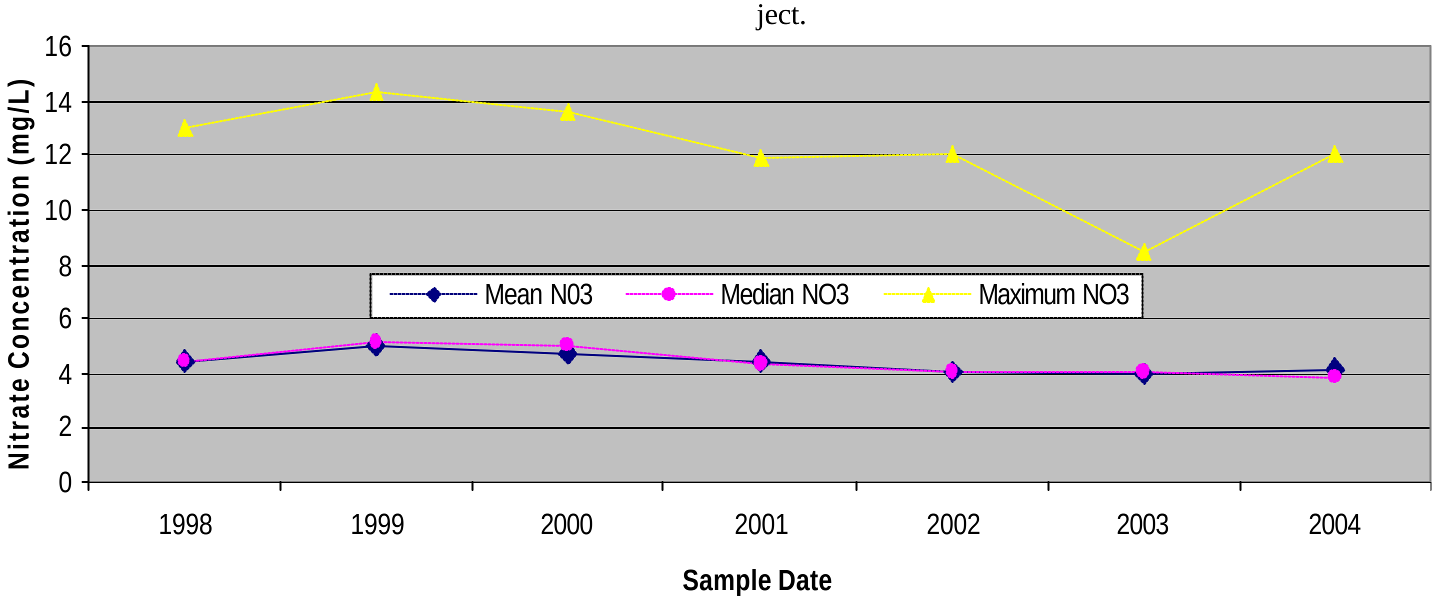


Figure 2. Time series line graph for nitrate concentrations 1998-2004.

Results

Sampling results for the seven years of testing indicate nitrate and pesticide impacts have occurred to the aquifer. Results are summarized and presented in the following sections.

Nitrate

Originally, ISDA sampled 75 wells in Twin Falls County, but over the years wells were dropped due to change in ownership or homeowners requesting not to be sampled anymore. This report focuses on 71 wells that were consistently sampled for NO_3-N (Nitrate) from 1998 through 2004. Results of that sampling indicates a slight decrease in both median and mean nitrate levels and in the number of wells that tested between 5 to 10 mg/L for nitrate (Table 1, Figure 2). In 1999, 36 or 51% of the wells sampled were over 5 mg/L for nitrate concentrations; a 12% increase from 1998 (Table 1). Since 1999, the number of wells with nitrate concentration in the range of 5-10 mg/L has decreased 16%. Wells showing elevated nitrate concentrations of 5 to 10 mg/L are dispersed throughout the project area (Figure 3). One well has tested over the MCL (10 mg/L) for nitrate six out of the seven sampling periods with concentrations ranging from 11.9 to 14.4 mg/L with a low of 8.4 mg/L.

Overall from 1998 to 2004 the average median nitrate concentration was 4.34 mg/L and the average mean nitrate concentration was 4.36 mg/L.

Although the nitrate concentrations from 1998 to 2004 have decreased, there is still a concern when 77% of the wells test above 2 mg/L, which is the level widely considered to indicate that contamination from land use has occurred (Figure 2).

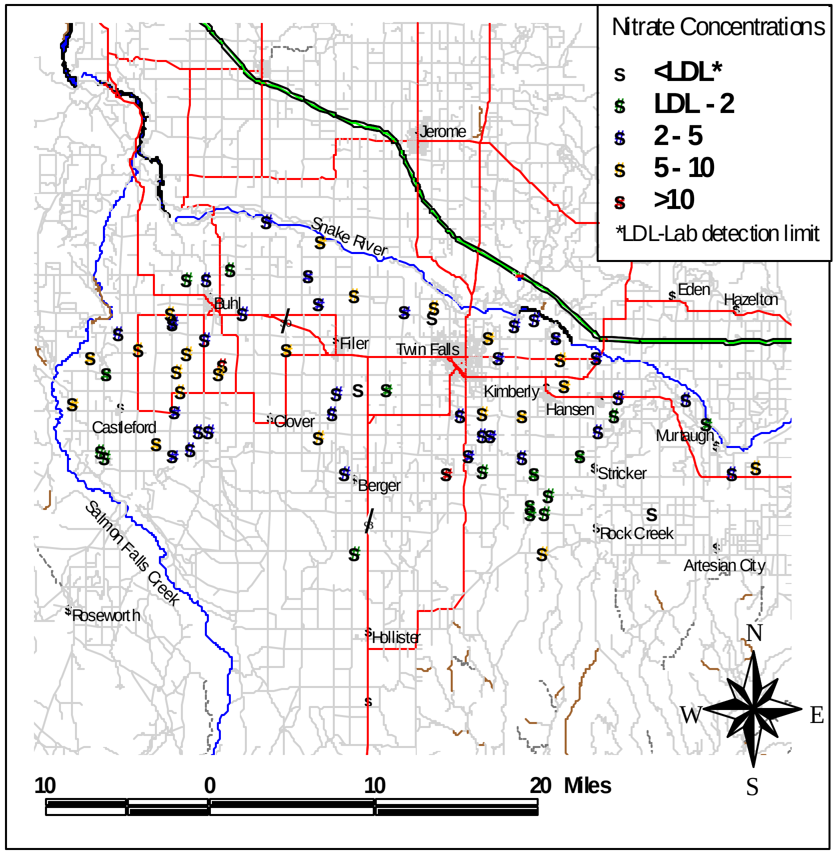


Figure 3. Locations of wells sampled by ISDA in Twin Falls County during the Spring of 2004. Colors represent nitrate concentration ranges measured in ground water from each well.

Table 1. Nitrate results for Twin Falls County regional monitoring project, 1998-2004.

Concentration Range (mg/L)	1998 71 Wells	1999 71 Wells	2000 71 Wells	2001 71 Wells	2002 71 Wells	2003 71 Wells	2004 71 Wells
<LDL* (0.033)	0	2(3%)	0	0	0	0	0
LDL to <2.0	12(17%)	6(8%)	10(14%)	13(18%)	14(20%)	13(18%)	16(23%)
2.0 to <5.0	30(42%)	26(37%)	26(37%)	30(42%)	38(54%)	40(56%)	33(46%)
5.0 to <10	28(39%)	36(51%)	33(46%)	27(38%)	18(25%)	18(25%)	20(28%)
>10	1(1%)	1(1%)	2(3%)	1(1%)	1(1%)	0	2(3%)
Median Value	4.5	5.1	4.9	4.3	3.8	4.0	3.8
Mean Value	4.4	5.0	4.7	4.4	4.0	3.9	4.1
Maximum Value	13	14.4	13.6	11.9	12	8.4	12
*LDL—Laboratory Detection Limit							

Nitrogen Isotopes

Overview

The ratio of the common nitrogen isotope ^{14}N to its less abundant counterpart ^{15}N relative to a known standard (denoted $d^{15}N$) can be useful in determining sources of NO_3-N. Common sources of NO_3-N in ground water are applied commercial fertilizers, animal or human waste, precipitation, and organic nitrogen within the soil. Each of these NO_3-N source categories has a potentially distinguishable nitrogen isotopic signature. Typical $d^{15}N$ ranges for fertilizer is –5 per mil ($^0/_{00}$) to +5 per mil ($^0/_{00}$), while typical waste sources have ranges greater than $10^0/_{00}$ (Kendall and McDonnell, 1998). Nitrogen isotope values between $5^0/_{00}$ and $10^0/_{00}$ are generally believed to indicate an organic or mixed source (Kendall and McDonnell, 1998).

Use of nitrogen isotopes as the sole means to determine NO_3-N sources should be done with great care. Nitrogen isotope values in ground water can be complicated by several reactions (e.g., ammonia volatilization, nitrification, denitrification, plant uptake, etc.) that can modify the $d^{15}N$ values (Kendall and McDonnell, 1998). Furthermore, mixing of sources along shallow flowpaths makes determination of sources and extent of denitrification very difficult (Kendall and McDonnell, 1998).

Findings

In 2001, 2002, 2003, and 2004 ISDA conducted $d^{15}N$ testing as a possible indicator of source(s) of NO_3-N in the ground water. 2004 samples were not analyzed at the time of this report. Wells that were chosen for $d^{15}N$ testing had elevated NO_3-N concentrations in previous monitoring rounds. Table 2 shows the $d^{15}N$ results along with NO_3-N concentrations.

In 2001, 2002, and 2003 $d^{15}N$ analysis of ISDA samples over 5mg/L were sent to North Carolina State University Laboratory (NCSUL) and to the Idaho Stable Isotopes Laboratory (ISIL) Department of Forest Resources College of Natural Resources at the University of Idaho. The NCSUL quit sampling for Isotopes in 2003 due to budget concerns so a portion of the 2003 samples were sent to the ISIL. Results of $d^{15}N$ testing returned values that ranged from $0.23^0/_{00}$ to $8.95^0/_{00}$ (Table 2). Over the course of isotope analysis from 2001 to 2003 no wells had values indicating an animal or human waste source.

Comparing the same 11 wells sampled from 2001-2003:

2001:
- 3 - fertilizer source.
- 8 - organic/mixed source.

2002:
- 4 - fertilizer source.
- 7 - organic/mixed source.

2003:
- 2 - fertilizer source.
- 9 - organic/mixed source.

Comparing the same 24 wells that were sampled for isotopes both in 2002 and 2003 (Figure 4 and Table 2):

2002:
- 11 - organic/mixed source.
- 13 - fertilizer.

2003:
- 19 - organic/mixed source.
- 5 - fertilizer source.

The isotope data suggests a decrease of fertilizer as the source of nitrate in groundwater and an increase in an organic/mixed source. This change may potentially be due to either: the increase in the number of cattle, 40,000 head since 1998 resulting in the substitution of manure for fertilizer; or an increase in septic system development. Organic as a source of nitrate is less likely because legume crop production has decreased 18,000 acres since 1998 (Ag Statistics Service).

Table 2. 2001, 2002 and 2003 $d^{15}N$ results for selected wells. Green highlighting indicates fertilizer source. Blue highlighting indicates organic/mixed source. Yellow highlighting indicates the 11 wells that were tested all three years. NA= not analyzed

Well ID	2001 DATA		2002 DATA		2003 DATA	
	NO3 (mg/L)	**$d^{15}N$ Values** ($^0/_{00}$)	NO3 (mg/L)	**$d^{15}N$ Values** ($^0/_{00}$)	NO3 (mg/L)	**$d^{15}N$ Values** ($^0/_{00}$)
7800901	5.74	6.86	4.9	5.07	5.5	6.7
7801201	6.91	7.45	6.3	7.63	5.7	8.53
7801601	11.9	7.19	9.7	6.29	6.2	2.68
7802301	5.19	NA	4.8	5.07	4.9	4.49
7802901	6.31	NA	6	5.55	6	4.62
7803301	6.57	3.98	6.48	4.11	6.8	7.99
7803601	8.87	5.66	8.9	2.5	8.4	6.57
7803701	6.12	5.37	6.8	.23	6.1	6.62
7803901	5.95	NA	5.5	3.71	5.3	6.52
7804101	5.36	NA	5.1	2.83	4.7	7.18
7804201	6	NA	5.6	3.07	5.4	5.73
7804301	8.32	5.89	7.6	7.45	6.9	8.32
7805001	5.9	NA	5	4.81	4.8	9.67
7805101	8.3	4.7	7.8	5.47	7.5	7.36
7805201	7.56	NA	4.7	3.09	4.8	6.34
7805501	6.38	NA	12	4.29	7.6	7.06
7805601	5.47	3.71	5.2	4.94	7.7	8.16
7805701	5.97	NA	6.4	8.36	5.2	7.32
7805901	5.44	NA	5.2	4.14	5.1	4.96
7806201	7.61	8.15	7	5.16	7.1	8.95
7806601	5.59	NA	4.9	5.45	4.8	6.58
7806701	5.21	5.42	3.1	4.82	4.2	6.12
7807301	5.97	NA	6	6.59	3	5.11
7807501	5.39	NA	5.4	.80	5.6	3.81

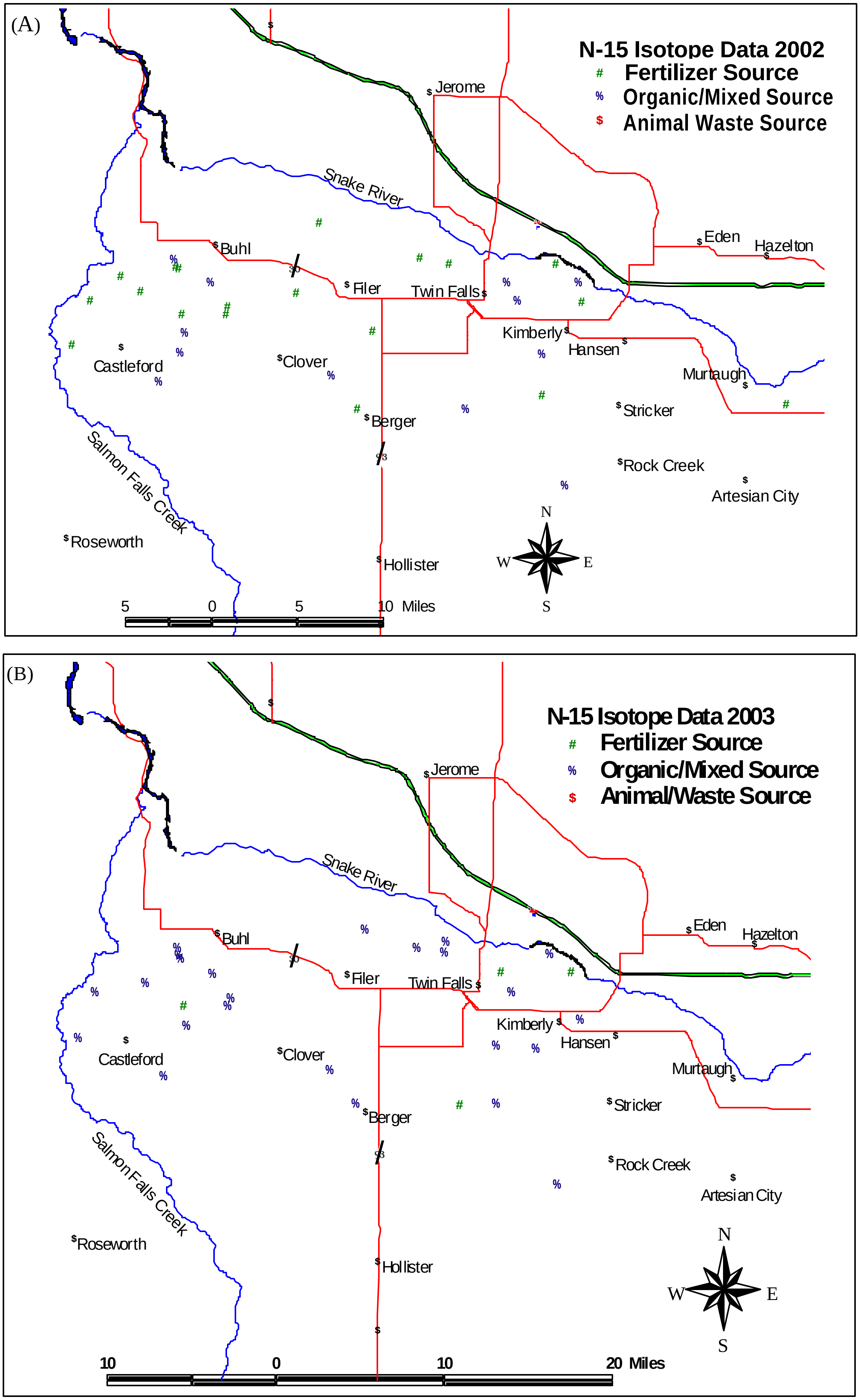


Figure 4. ISDA well locations and their associated N15 Isotope (nitrate) source as indicated by color for (A) 2002 and (B) 2003.

Pesticides

In 1998, 2000, and 2002 (Figure 5) 75 well water samples were sent to the UIASL. In 1999 21 wells were sampled for follow-up of pesticide detects in 1998 and in 2001 32 wells were sampled for follow-up of pesticide detects in 2000. Samples were tested for various pesticides utilizing EPA Methods 507, 508, and 515.1, and 531.1.

Numerous pesticides were detected throughout the project area; however, detections were typically low in concentration. Atrazine and dacthal were detected in multiple well samples all four years. In addition to atrazine and dacthal, diazinon was detected in 1998 and propazine and picloram were detected in 2000.

Table 3. Pesticide results for Twin Falls County regional ground water monitoring project, Spring 1998.

Pesticide Detects	Number Detects (75	Range (µg/L)	Health Standard (µg/L)
Atrazine	14	0.01 - 0.23	3 (MCL)*
Dacthal	3	0.05 - 0.28	70 (RfD)**
Diazinon	1	0.41	.01(RfD)**

Table 4. Pesticide results for Twin Falls County ground water monitoring regional project, Spring 2000

Pesticide Detects	Number Detects (75 wells)	Range (µg/L)	Health Standard (µg/L)
Atrazine	19	0.03 - 0.19	3 (MCL)*
Dacthal	6	0.09 - 17	70(RfD)**
Propazine	1	0.02	20(HAL)**
Picloram	1	.27	500 (HAL)**

The only pesticide with a detection level above the health standard set by the EPA or the State of Idaho was diazinon. All other pesticide detections were below the health standard. Atrazine detections increased 30% between 2000 and 2002 testing. Wells showing concentrations above the EPA health standard for diazinon in 1998 were below laboratory detection limits in 1999 and haven't been detected since.

Table 5. Pesticide results for Twin Falls County ground water monitoring regional project, Spring 1999.

Pesticide Detects	Number Detects (21 wells)	Range (µg/L)	Health Standard (µg/L)
Atrazine	5	0.03-0.08	3 (MCL)*
Dacthal	1	0.13	70 (RfD)**

Table 6. Pesticide results for Twin Falls County ground water monitoring regional project, Spring 2001.

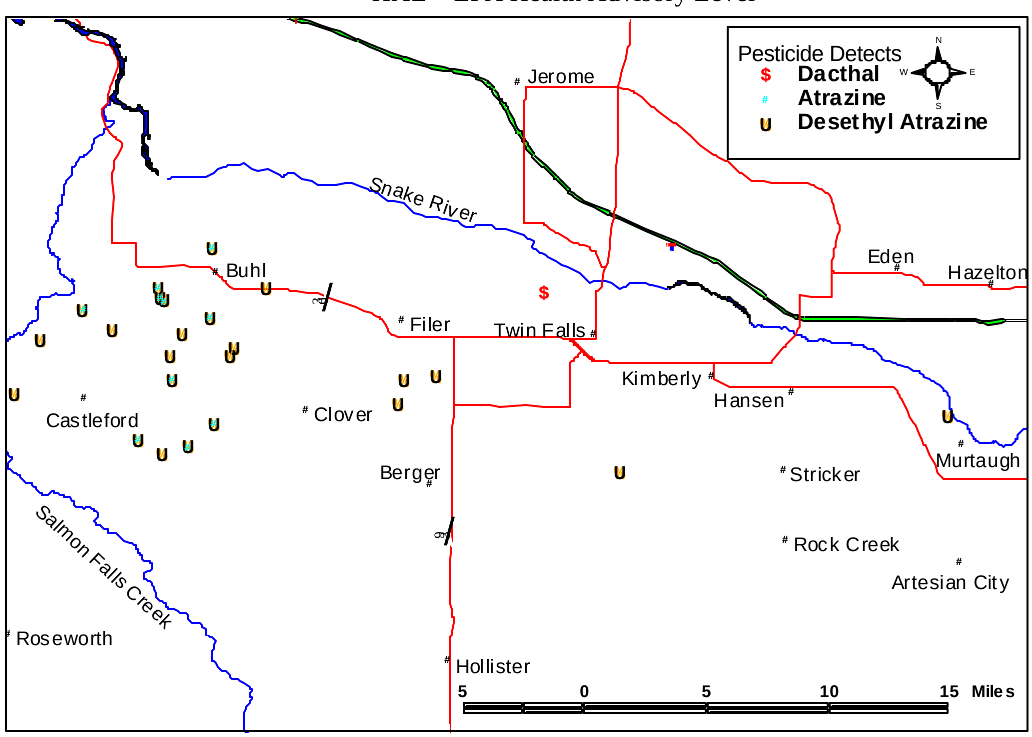
Pesticide Detects	Detects (32 wells)	Range (µg/L)	Health Standard (µg/L)
Atrazine	9	0.03-0.08	3 (MCL)*
Dacthal	1	0.03-0.31	70 (RfD)**
Desethyl Atrazine	16	0.15	3 (RFD)**
Bromacil	1	0.15	90 (HAL)***

Table 7. Pesticide results for Twin Falls County ground water monitoring regional project, Spring 2002.

Pesticide	Number Detects	Range (µg/L)	Health Standard
Atrazine	36	0.03 - 0.27	3 (MCL)*
Dacthal	1	0.18	70 (RfD)**

* MCL - EPA Maximum Containment Level
** RfD - EPA Reference Dose for 10 kg Child
*** HAL - EPA Health Advisory Level

Figure 5. Locations of wells with pesticide detections sampled by ISDA in Twin Falls County Spring 2002.



Conclusions

Ground water within the volcanic and sedimentary aquifer of the project area is being impacted from nitrates and pesticides. However, mean and median ground water nitrate levels have decreased between 1999 and 2004. In 1999, 51% of the 71 wells sampled were over 5 mg/L for nitrate compared to 2004 where 28% of the wells sampled were over 5 mg/L for nitrate; an overall decrease of 23%. Although the overall number of nitrate detections over 5 mg/L have decreased, 74% of the wells are still considered contaminated with nitrate because they are above the natural background level of 2 mg/L nitrate.

Although pesticide concentrations are generally low, the frequency of pesticide detections also is of concern, in part, because of multiple pesticide detections per well. Health risks associated with consuming low level concentrations of more than one pesticide compound is unknown.

Numerous types of pesticides were detected in the project area. Only one well showed concentrations above the EPA health standard for diazinon, which was not detected in follow-up monitoring in 1999. Atrazine, desethyl atrazine, and dacthal detections were the most common with atrazine detections increasing 30% between 1998 and 2002. ISDA will sample pesticides again in 2005.

Agricultural practices are likely a contributor to nitrate and pesticide detections in the ground water of this project area. Testing results indicate nitrate and pesticide impacts to ground water of the project area are widespread. Leaching of applied commercial fertilizers and animal waste are potentially a major cause of nitrate entering the ground water.

Recommendations

To determine if current agricultural and pesticide application practices are contributing to ground water degradation and to locate other potential contaminant sources, the ISDA recommends continued monitoring in the project area with increased focus in areas where wells are above 5 mg/L.

The ISDA recommends that measures to reduce nitrate and pesticide impacts on ground water be addressed and implemented. The ISDA recommends that:

- Growers and agrichemical professionals conduct nutrient, pesticide, and irrigation water management evaluations.
- Producers follow the Idaho Agricultural Pollution Abatement Plan and Natural Resources Conservation Service Nutrient Management Standard.
- Dairies, Confined Animal Feeding Operations, and other animal feeding operations complete, update, and implement nutrient management plans according to state and federal standards.
- Producers and agrichemical dealers evaluate their storage, mixing, loading, rinsing, containment, and disposal practices.
- Homeowners assess lawn and garden practices, especially near wellheads.
- Local residents assess animal waste management practices.
- South Central District Health and Twin Falls Regional Office assess impacts from private septic systems.
- Home and garden retail stores establish outreach programs to illustrate proper application and management of nutrients and pesticides.
- Responsible parties assess current pesticide application practices to non-crop areas (example: roadsides, railroad areas, etc.).

The ISDA recommends that the Balanced Rock, Snake River, and Twin Falls Soil and Water Conservation Districts continue to coordinate with the Twin Falls County Ground Water Quality Management Committee to work with agriculture on best management practices for improved irrigation, pesticide, and nutrient management. In addition, the University of Idaho Extension should work with local agrichemical professionals, landowners, and agencies to implement this process and seek funding to support these efforts. The ISDA will support these local partners in seeking funding and implementing a comprehensive program.

References

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